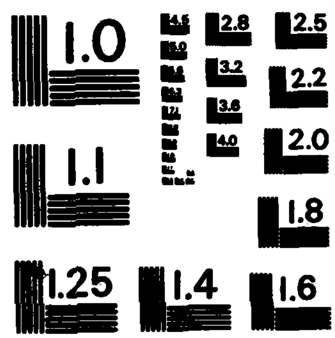
AD-A121 945 ANALYTIC INVESTIGATION OF FREE BOUNDARY PROBLEMS(U) 1/1
RENSSELAER POLYTECHNIC INST TROY NY B A FLEISHMAN
NOV 82 ARO-13081.5-MA DAAG29-75-C-0021

UNCLASSIFIED F/G 12/1 NL

END
FILMED
DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

REPORT NUMBER: 13081.5-MA; 16173.5-MA	2. GOVT ACCESSION NO.: AD-A121945
3. RECIPIENT'S CATALOG NUMBER	
TITLE (and Subtitle): Analytic Investigation of Free Boundary Problems	5. TYPE OF REPORT & PERIOD COVERED: Final: 1 Jun 75 - 30 Jul 82
	6. PERFORMING ORG. REPORT NUMBER
AUTHOR(s): Bernard A. Fleishman	8. CONTRACT OR GRANT NUMBER(s): DAAG29 75 C 0021; DAAG29 79 C 0012
PERFORMING ORGANIZATION NAME AND ADDRESS: Rensselaer Polytechnic Institute, Troy, NY 12181	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
CONTROLLING OFFICE NAME AND ADDRESS: U. S. Army Research Office, Post Office Box 12211, Research Triangle Park, NC 27709	12. REPORT DATE: Nov 82
	13. NUMBER OF PAGES: 4
MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

DTIC ELECTE NOV 30 1982

A

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

NA

18. SUPPLEMENTARY NOTES

The view, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documentation.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

boundary value problems
differential equations
nonlinear boundary value problems
elliptic partial differential equations
free boundaries

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

We have investigated a number of nonlinear boundary value problems, usually steady-state, of reaction-diffusion type. Though a few problems have involved ordinary differential equations, we have been concerned mostly with elliptic partial differential equations. Of special interest have been nonlinearities with jump discontinuities in the dependent variable, giving rise to free boundaries.

DD FORM 1473, 1 JAN 73 — EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

82 11 29 076

FINAL REPORT

ARO Proposal Number: P-16173-M

Period Covered: 1 December 1975 - 31 July 1982

Project Title: "Analytic Investigation of Free Boundary Problems"

Contract Numbers: DAHC04-75-0021
DAAG29-75-C-0021
DAAG29-79-C-0012

Name of Institution: Rensselaer Polytechnic Institute

Author of Report: Professor Bernard A. Fleishman,
Principal Investigator

DESCRIPTION OF PROBLEM AREAS AND PRINCIPAL RESULTS

Under the subject contract we have investigated a number of nonlinear boundary value problems, usually steady-state, of reaction-diffusion type. Though a few problems have involved ordinary differential equations, we have been concerned mostly with elliptic partial differential equations. Of special interest have been nonlinearities with jump discontinuities in the dependent variable, giving rise to free boundaries.

Thus, much of our work may be described as an investigation of elliptic free boundary problems (FBP's). In particular, we have studied the applicability of classical methods of analysis to the solution of such FBP's. In [3,5] (see "List of Publications" below), for example, the existence of a solution to a particular FBP has been established by a method of monotone iteration. For several FBP's [2,3,4] a method of perturbation (or linearization) has been shown to yield, in an easily applied manner, approximate solutions. In papers providing a rigorous justification for this approach [8,9], the scope of the study was broadened to include a closely related eigenvalue problem and bifurcation results.

Along the way there have been tangential investigations of (a) the multiplicity and stability of solutions in a step-function model for a chemical reactor [6]; (b) a minimum principle for superharmonic functions subject to interface conditions [7]; (c) a variety of results for ODE's with discontinuous nonlinearities [1]; and (d) studies of a simple but informative nonlinear eigenvalue problem [10,11].

Still active is a study of FBP's arising from a model of plasma equilibrium (collaborator: Lee Tsao) and a generalization of the iteration results in [5] to a wider class of nonlinearities (collaborator: Ross Gingrich).

LIST OF PUBLICATIONS

1. "Boundary value problems with discontinuous nonlinearities: comparison of solutions, approximation, and continuous dependence on parameters" by B. A. Fleishman and T. J. Mahar, Journal of Differential Equations 26, 262-277 (1977).

2. "A perturbation method for free boundary problems of elliptic type" by B. A. Fleishman and T. J. Mahar, pp. 159-167 of TRANSACTIONS OF THE 22nd CONFERENCE OF ARMY MATHEMATICIANS, ARO Report 77-1 (1977).

3. "Analytic methods for approximate solution of elliptic free boundary problems," by B. A. Fleishman and T. J. Mahar, Nonlinear Analysis 1, 561-569 (1977).

4. "Application of classical analytical techniques to steady-state free boundary problems," by Bernard A. Fleishman, Ross Gingrich and Thomas J. Mahar, pp. 41-55 of MOVING BOUNDARY PROBLEMS (eds. D. G. Wilson, Alan D. Solomon and Paul T. Boggs), Academic Press, New York (1978).

5. "On the existence of classical solutions to an elliptic free boundary problem" by Bernard A. Fleishman and Thomas J. Mahar, pp. 39-57 of DIFFERENTIAL EQUATIONS AND APPLICATIONS (eds. W. Eckhaus and E. M. deJager), North-Holland Publ. Co. (1978).

6. "A step-function model in chemical reactor theory: multiplicity and stability of solutions" by Bernard A. Fleishman and Thomas J. Mahar, Nonlinear Analysis 5 (6), 645-654 (1981).

7. "A minimum principle for superharmonic functions subject to interface conditions," by Bernard A. Fleishman and Thomas J. Mahar, Journal of Mathematical Analysis and Applications 80 (1) 46-56 (1981).

8. "Perturbation and bifurcation in a discontinuous nonlinear eigenvalue problem," by Roger K. Alexander and Bernard A. Fleishman, to appear in the proceedings of the "International Conference on Nonlinear Phenomena in Mathematical Sciences."

9. "Perturbation and bifurcation in a free boundary problem," by Roger K. Alexander and Bernard A. Fleishman, Journal of Differential Equations 45, 34-52 (1982).

10. "A simple boundary value problem with infinitely many solutions," by Paul W. Davis and Bernard A. Fleishman, submitted to SIAM Review.

11. "Eine kleine eigenvalue problem," by Paul W. Davis and Bernard A. Fleishman, to appear in PROCEEDINGS OF THE 28th CONFERENCE OF ARMY MATHEMATICIANS.

LIST OF PARTICIPATING SCIENTIFIC PERSONNEL

Dr. Bernard A. Fleishman, R.P.I., Principal Investigator.

Dr. Paul W. Davis, Worcester Polytechnic Institute, research associate.

Dr. Thomas J. Mahar, Northwestern University, research associate.

Ross Gingrich, research assistant (now writing the first draft of his doctoral dissertation).

Lee Tsao, research assistant.